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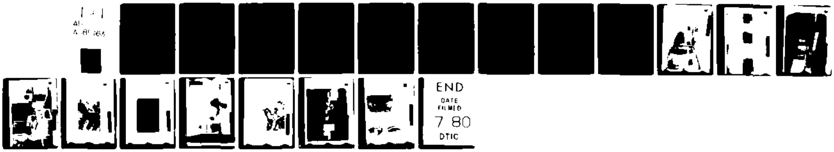

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The Defense Mapping Agency Aerospace Center has developed a program to exploit digital image technology for the advancement of mapping, charting, and geodesy. Primary investigations include image processing, analysis, and display techniques, and computer image generation. A dramatic impact has been made in the ability to produce, analyze, and validate various digital data bases produced by the Defense Mapping Agency by applying state-of-the-art digital image technology concepts to the development of new interactive prototype and production systems.

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DIGITAL IMAGE TECHNOLOGY: 1980 EMERGING PRODUCTION APPLICATIONS

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BIOGRAPHICAL SKETCH

Marshall B. Faintich is a Physical Scientist in the Advanced Technology Division, Systems and Techniques Directorate, at the Defense Mapping Agency Aerospace Center (DMAAC) in St. Louis, Missouri. He received his B.S. degree in Applied Mathematics from the University of Missouri at Rolla, and his M.S. and Ph.D. in Astronomy from the University of Illinois at Urbana-Champaign. He was involved in satellite systems research at the Naval Weapons Laboratory (now NSWC) Dahlgren, Virginia, from 1971 to 1974, and was detailed to the Engineer Topographic Laboratories for study in digital image processing. He has been involved in geodetic studies, sensor scene simulation, and digital image technology at the DMA Aerospace Center, and was detailed to L'Institut Geographique National, Paris, France, on a technical exchange. He has authored numerous technical papers on astrodynamics, computerized simulation, and digital image technology.

ABSTRACT

The Defense Mapping Agency Aerospace Center has developed a program to exploit digital image technology for the advancement of mapping, charting, and geodesy. Primary investigations include image processing, analysis, and display techniques, and computer image generation. A dramatic impact has been made in the ability to produce, analyze, and validate various digital data bases produced by the Defense Mapping Agency by applying state-of-the-art digital image technology concepts to the development of new interactive prototype and production systems.

INTRODUCTION

With the introduction of digital image technology into the scientific community, the Defense Mapping Agency (DMA) began a program to exploit this technology for the advancement of mapping, charting, and geodesy (MC&G). Primary areas of in-house application engineering are image processing, image analysis for automated feature extraction, image display techniques for data base analysis, and computer image generation/sensor simulation for advanced weapon systems support (Faintich, 1979). Specialized digital image technology hardware for production systems is continuing to be developed and procured as a result of investigations using the major developmental hardware at DMA during the 1974-1980 time frame, the OPTRONICS Scanning, Digitizing, and Reimaging (SDR) System (see Figure 1).

IMAGE PROCESSING

To support both image analysis and electro-optical correlation systems, DMA has developed a general purpose digital image processing software package to accomplish image restoration, enhancement, noise removal and geometrical warping. Spatial convolution filters, pixel histogram manipulations, transform coding and filtering, and compression techniques are included. In order to allow for extensive in-house digital testing with digital stereo displays and interactive image scanning, DMA is installing Remote Work Processing Facilities (RWPF) in the production centers during 1980 (see Figure 2). The RWPF will be augmented with the DMA image processing software package and new algorithms as they are developed. After installation, the major portions of pilot MC&G digital operations, digital photo interpretation and feature extration, and general digital image technology experimentation will be conducted on the RWPF. Future plans for the RWPF include linkage of the systems to major image processing installations.

IMAGE ANALYSIS FOR AUTOMATED FEATURE EXTRACTION

Some of the major programs at the DMA are the production of digital data bases that describe the physical appearance of the surface of the earth. These data bases include, but are not limited to, terrain elevation, culture including landscape characteristics, and vertical features. A major problem in the production of these digital data bases is the extreme cost of primarily manual photo interpretation of surface features. Various digital techniques are being investigated to develop a digital image analysis capability for feature extraction. The developments are addressing automated classification from both multi-spectral and conventional black and white imagery.

Initial goals are being addressed by the procurement of a Digital Interactive Multi-Image Analysis System (DIMIAS) which will primarily exploit LANDSAT Multi-Spectral Scanner (MSS) data (see Figure 3 and 4). Investigations demonstrated that LANDSAT multi-spectral data can be used to meet current production standards for landscape feature extraction, with a significant increase in the throughput rate. The projected manhour savings was 15 percent of the feature analysis time for areas the DIMIAS will process. The first DIMIAS was delivered to DMA in July 1979. Essential aspects of this system, which provided an initial production capability in March 1980,are its automated processing capability and interaction with the feature analyst for on-line manipulation. Provision has been made for the acquisition of two additional systems in 1980. Figures 5 and 6 are samples of the LANDSAT imagery with calibration areas delineated and the resulting extracted landscape features, respectively. Future systems will incorporate algorithms to exploit conventional black and white imagery.

IMAGE DISPLAYS FOR DATA BASE ANALYSIS

The digital terrain elevation data produced by the Defense Mapping Agency supports a wide variety of products, including input to electro-optical sensor simulators, guidance systems, and automated cartographic systems. This data is collected from source maps using the Lineal Input System, and from stereo-pairs of photographic imagery using optical correlation processes. In order to facilitate the display of these data bases for analysis, techniques for various types of display have been developed.

Along classical MC&G lines, a digital terrain elevation matrix may be used to generate a standard contour plot and the corresponding tint plate. For advanced analysis, terrain data may be depicted in the form of gray level elevation code or shaded relief from various sun angles. In addition, photogrammetric models may be applied with shaded relief techniques to generate pseudo-stereo-pairs from the data bases. Additional information is gained from applying digital image convolution techniques to the digital terrain elevation data. Convolution techniques allow for one meter level analysis of the digital elevation data.

These advanced techniques have been incorporated into production quality control units called Image Manipulation Stations (IMS, see Figure 7). An example of color analysis of a convolved terrain elevation matrix is shown in Figure 8. The IMS units will be eventually integrated into the Digital Data Base Analysis System (DBAS), a system being developed to manage the DMA digital cartographic data bases.

COMPUTER IMAGE GENERATION/SENSOR SIMULATION

The primary objective of the digital sensor simulation investigations being conducted at DMA is to establish an editing and analysis capability for the digital culture and terrain data bases. These data bases are being produced by DMA to support advanced aircraft simulators by providing an improved low level radar training capability offered by the digitally generated radar landmass images. As a result of the technology developed for the aircraft simulator support, sensor guidance reference scenes are also being generated. In addition to radar scenes, visual and multi-sensor scenes are being digitally generated. For purposes of quality control and data base applicability investigations, the DMA is developing the Sensor Image Simulator (SIS), a very high speed data base edit station and static scene simulator that allows for interactive query of individual features in the simulated sensor scene to determine the corresponding data base elements responsible for the simulated features (see Figure 9). The SIS will be installed at DMA in the fall of 1980, and is expected to play a key role in determining the applicablity of prototype data bases for use in advanced training simulators, as well as to insure the quality of and coherence between the various digital data bases prior to new data insertion into the master cartographic data base files (Figure 10).

CONCLUSIONS

The development of digital image technology has made a dramatic impact upon classical production methodologies for mapping, charting, and geodesy. DMA has begun to develop a new line of digital products to support advanced aerospace weapons systems, and digital image technology systems are playing a key role in the production,analysis,and validation of these products.

REFERENCE

1. Faintich, M.B.; 1979; "Digital Image Technology: MC&G Impact," Harvard Computer Graphics Week '79, 15-20 July 1979; reprinted in the <u>Proceedings of the American Society of Photogrammetry</u>, Annual Convention, St. Louis, Missouri, 9-14 March 1980.

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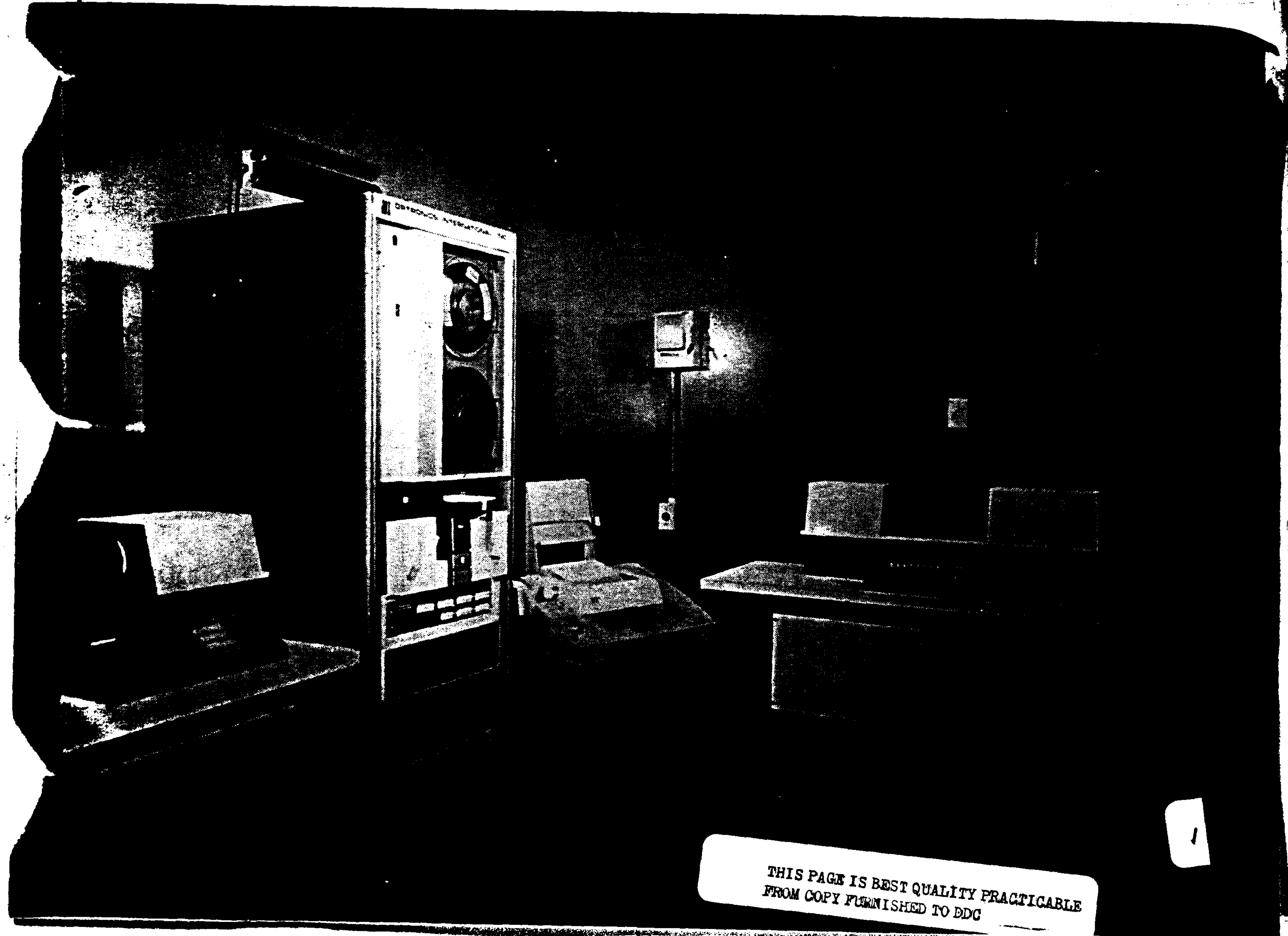

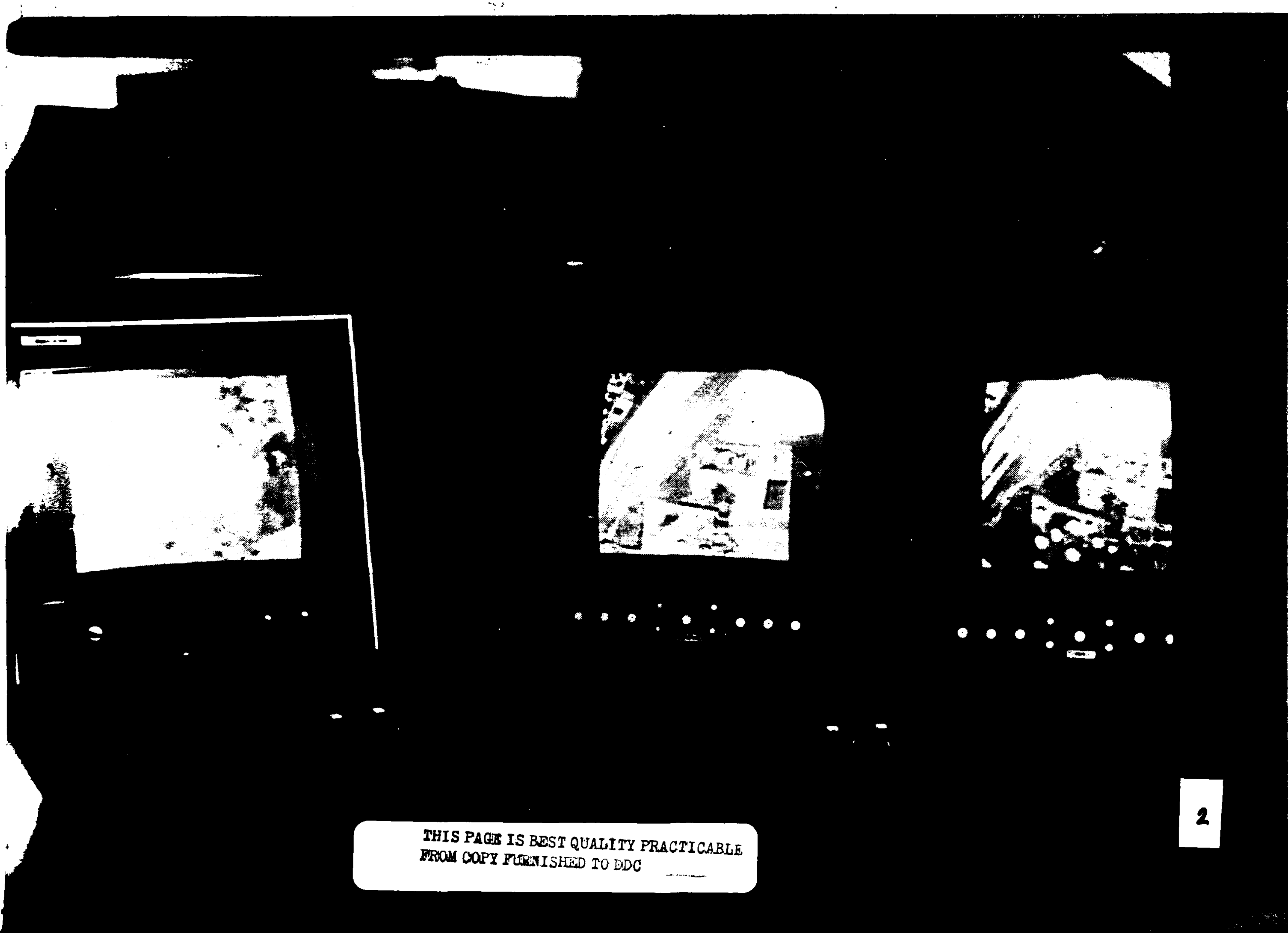

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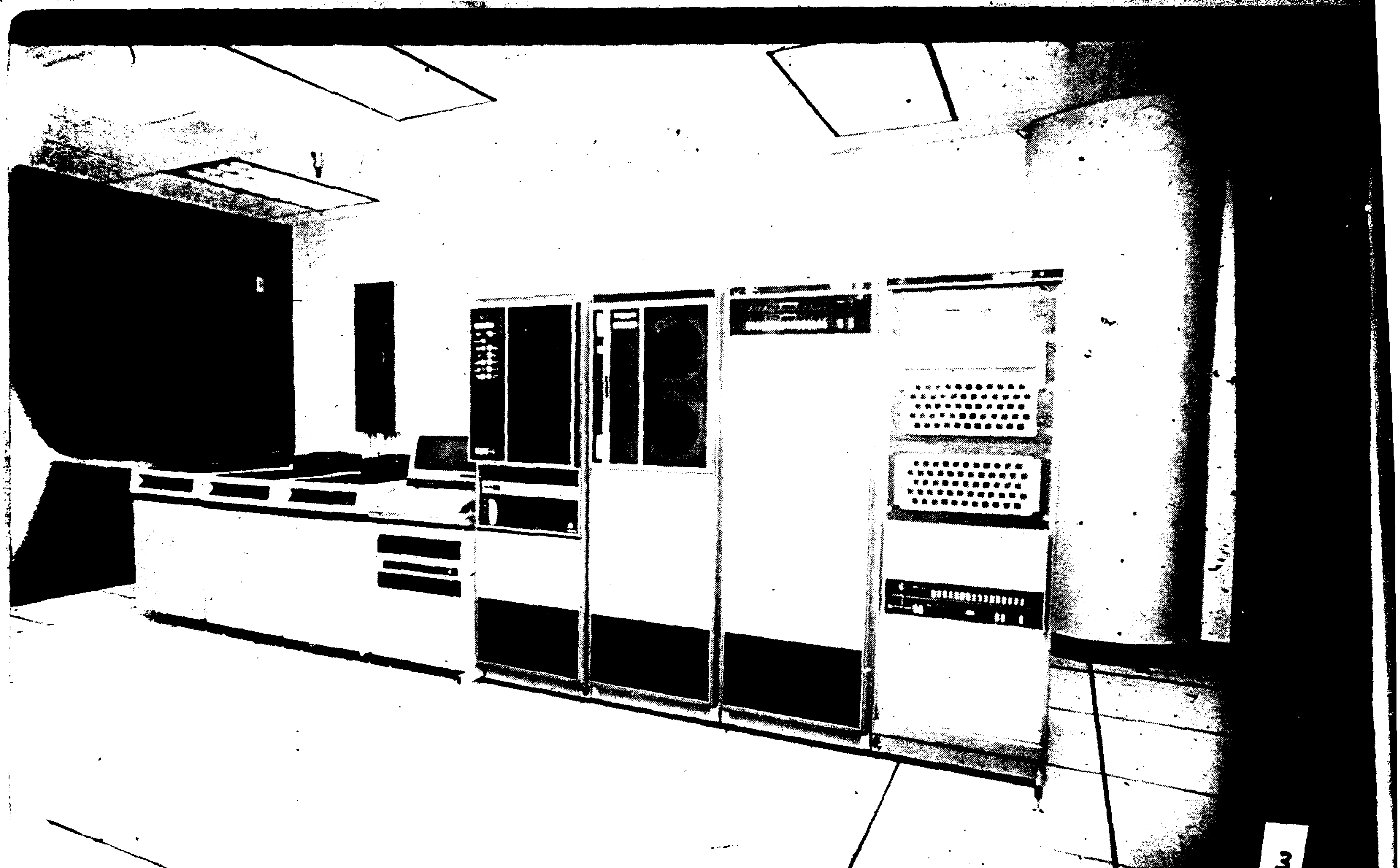

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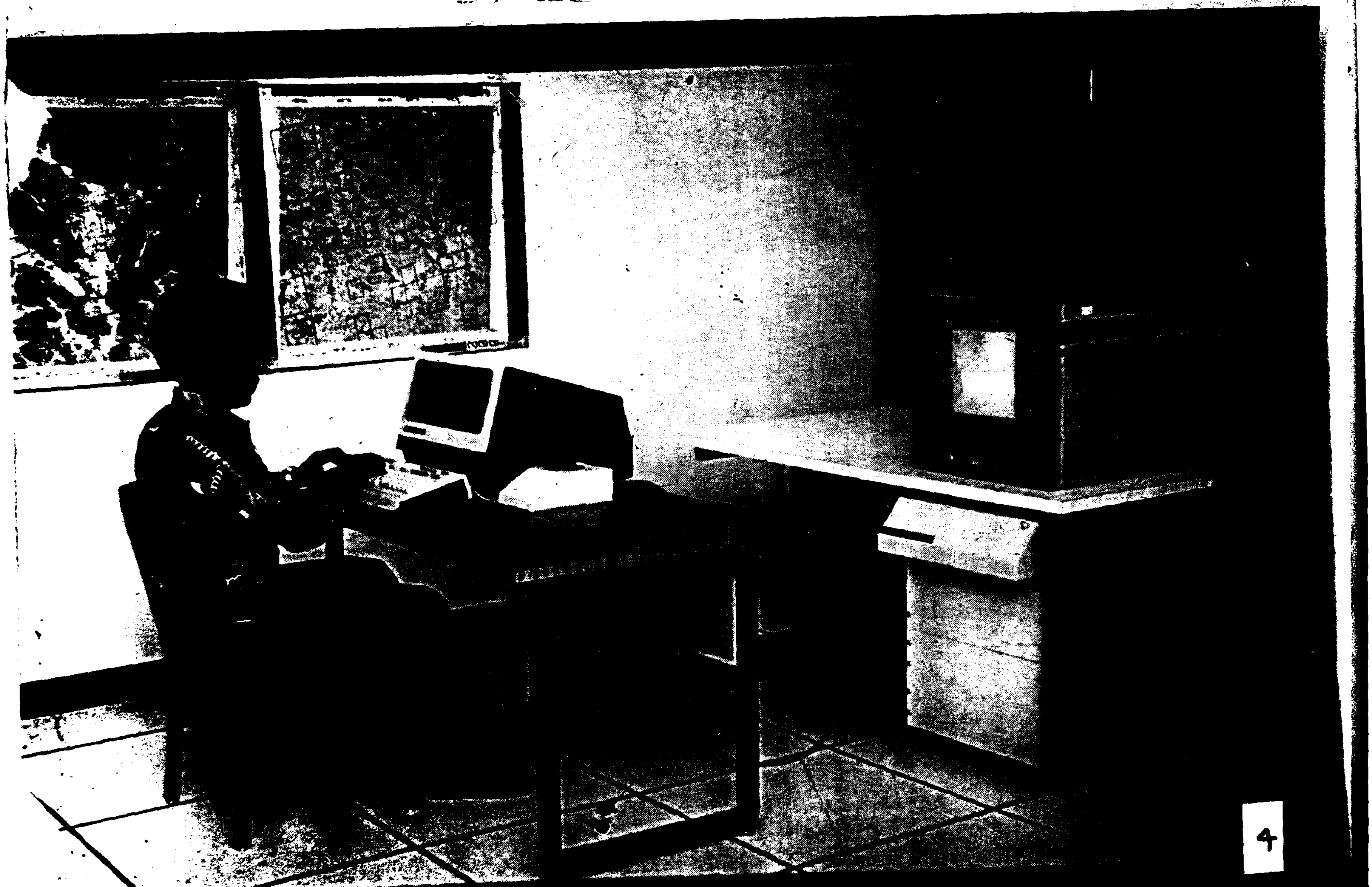
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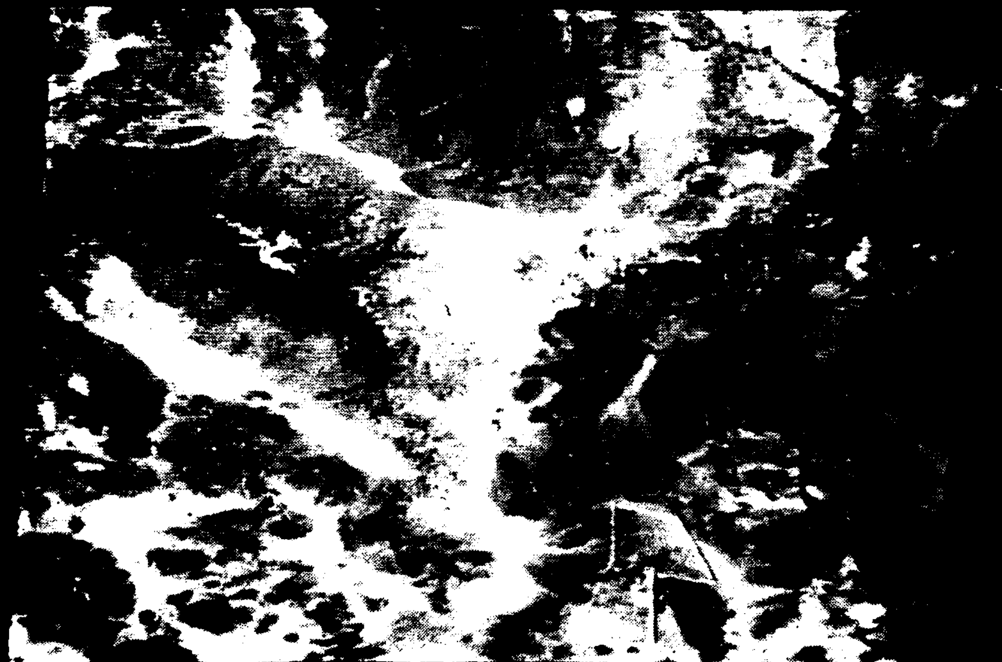

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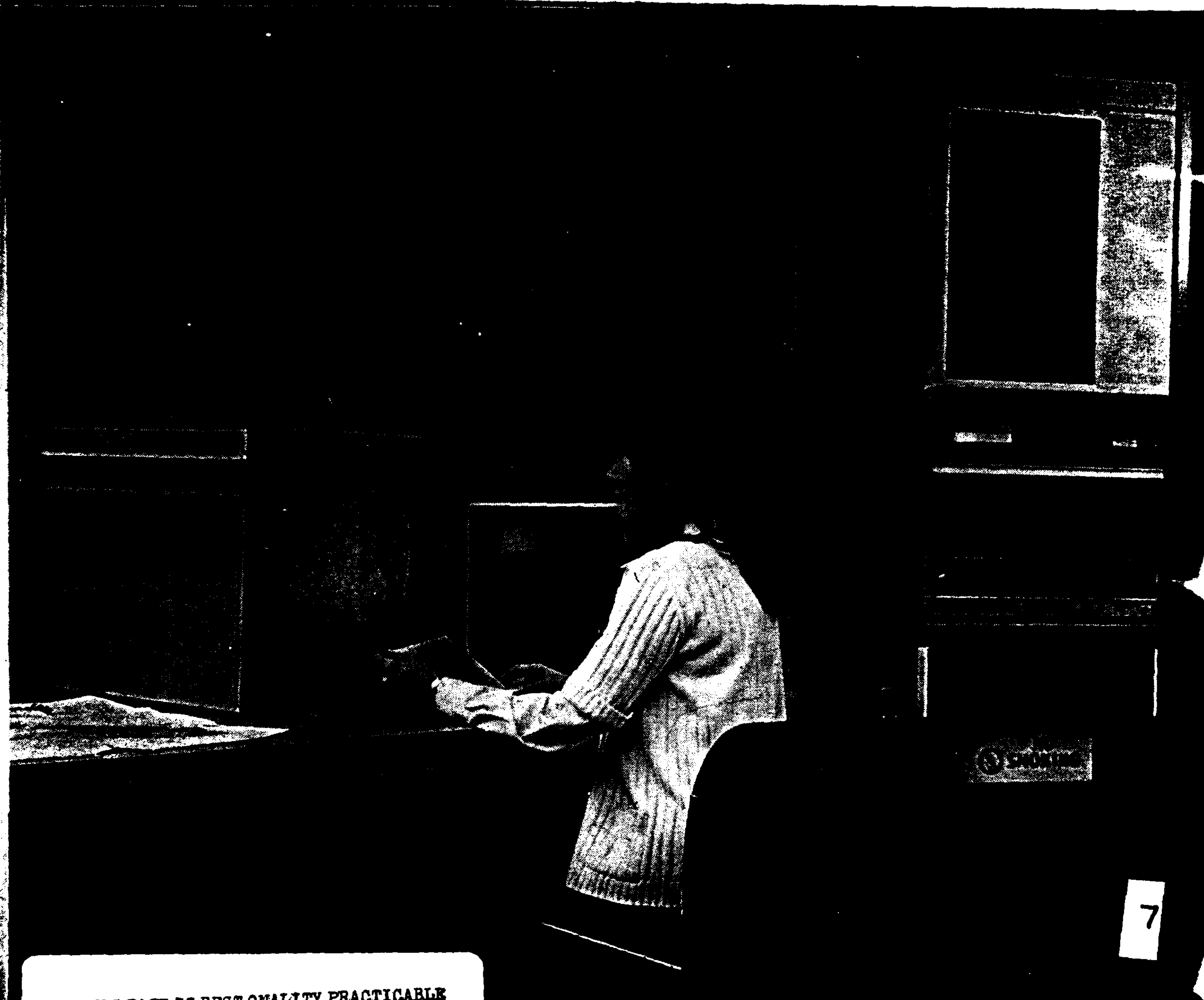
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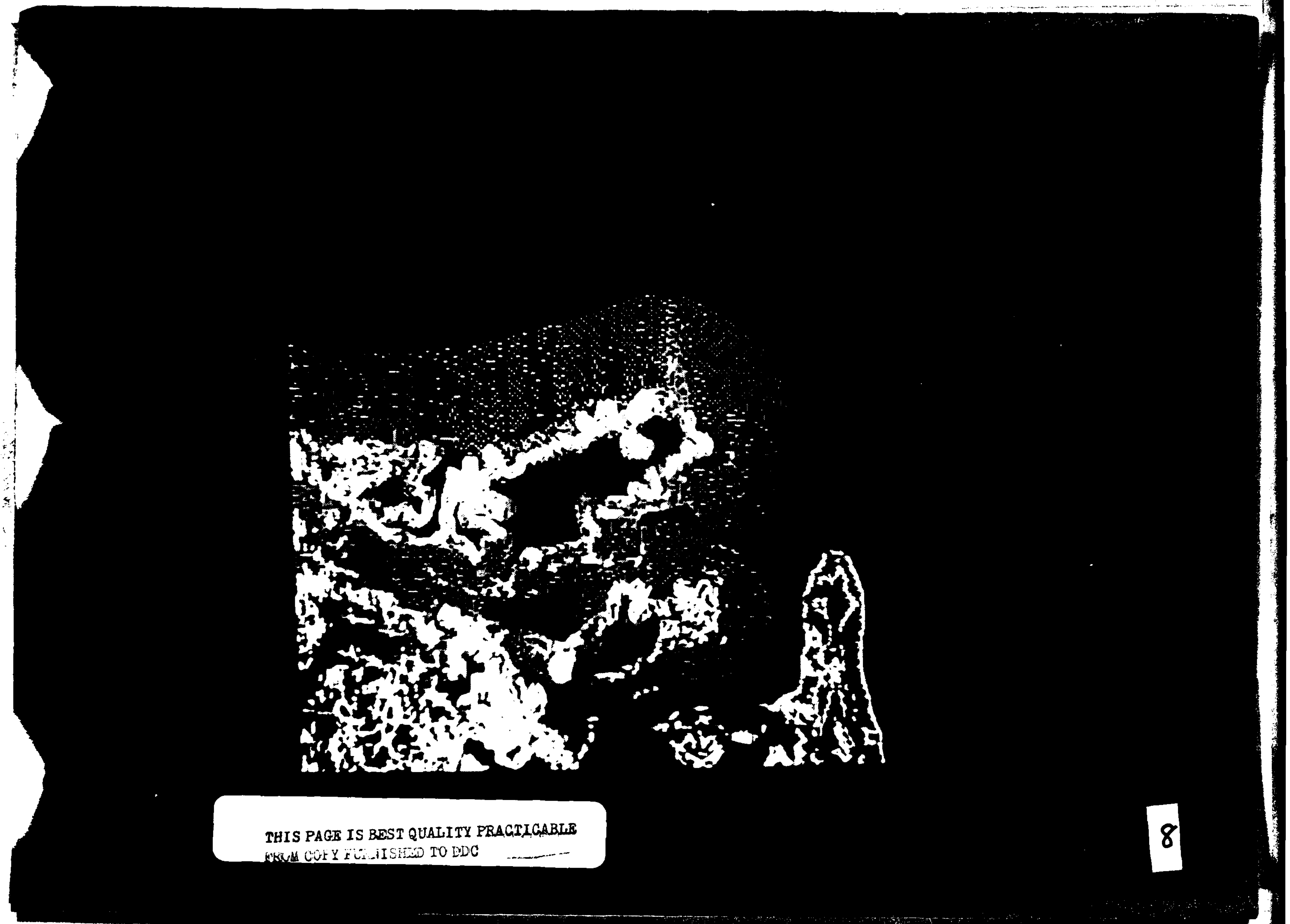

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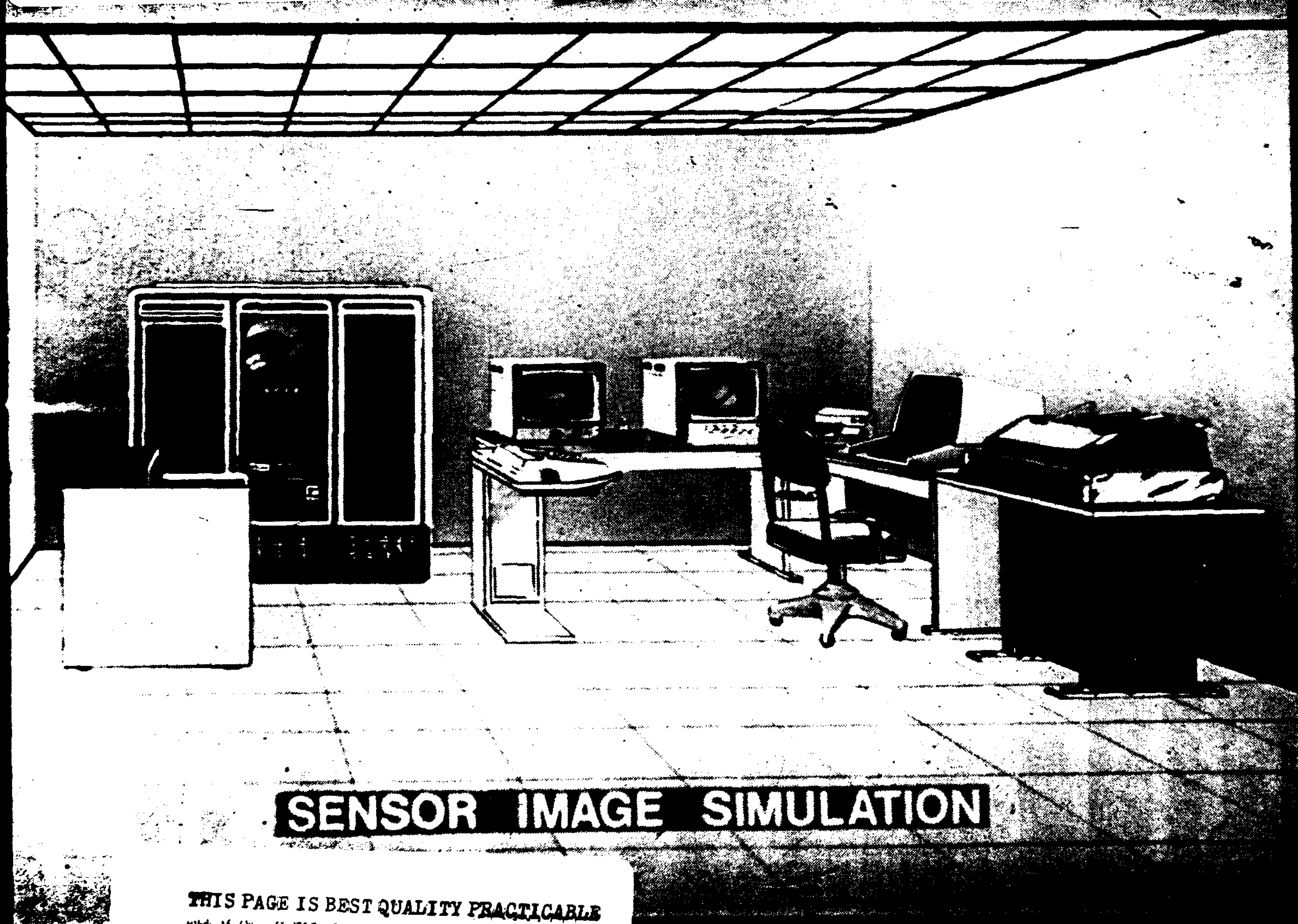

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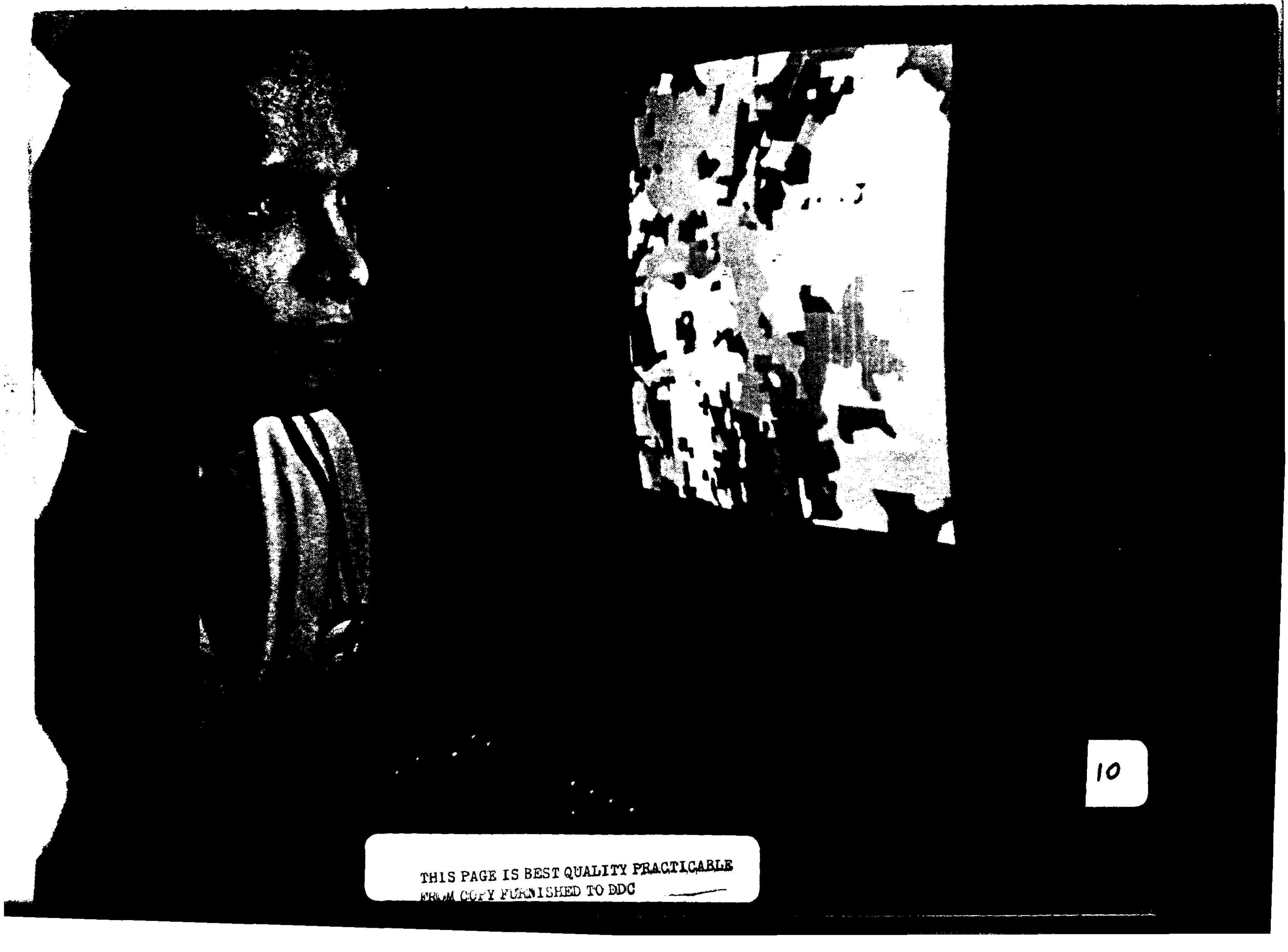
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